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A Personal Monitoring Study to Assess Workplace Exposure to Environmental Tobacco Smoke

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Abstract: We enrolled 15 nonsmoking volunteers to evaluate the feasibility of measuring personal exposure to environmental tobacco smoke (ETS) at work and to characterize workplace exposures. During one workshift, we obtained questionnaires on exposure, saliva and urine for cotinine, and personal air samples for respirable particles and nicotine. The levels of cotinine, respirable particles, and nicotine varied widely with self-reports of exposure to ETS, but on average increased with increasing exposure. (*Am J Public Health* 1990; 80:988–990.)

Introduction

While health effects of passive smoking on children and adults have been identified, the principal location of exposure investigated has been the home.[1,2] Workplace exposure has received less attention, and health effects of environmental tobacco smoke (ETS) in the workplace remain controversial.

We enrolled 15 nonsmoking adults to determine the feasibility of measuring personal exposure to ETS at work and to characterize workplace exposures of this small group of subjects. Indicators of exposure, measured during a workday, included questionnaires, personal samples for respirable particles (RSP) and nicotine, and urinary and salivary cotinine.

Methods

Between October 1986 and May 1987, 15 nonsmoking volunteers (eight men, seven women), 18 years of age and older, were recruited from the Albuquerque, New Mexico area. We obtained exposure questionnaires, saliva, urine, and personal air particle samples during one workshift. The saliva and urine specimens were obtained before and after the workshift. Cotinine was quantitated by a double antibody radioimmunoassay, as described by Langone, *et al.*[3] Details of the assay in our laboratory have been reported previously.[4]

During the workshift, each subject wore a personal monitoring pump running at 1.7 l/min with a 10 mm nylon cyclone clipped to the shirt collar.[5] RSP samples were collected on 37 mm Fluropore filters (Millipore Corp). Nicotine was collected on a glass fiber backup filter treated with sodium bisulfate to minimize volatilization; after extraction from the filter, analysis for nicotine was done on a gas chromatograph with a flame ionization detector.[6] The recovery of nicotine by this procedure has been shown to be 98 percent efficient.

From the questionnaires, we derived measures of exposure including the total number of cigarette smokers and total number of hours exposed during the workshift. To describe the relationships among the measures of ETS exposure, Spearman correlations were calculated. Data analysis was performed with standard programs.[7]

Results

Occupations of the subjects were diverse (Table 1); mean age was 44.8 years; average duration of the workshift and of the personal monitoring was 6.5 hours (SD ± 2.0).

Exposure to cigarette smokers at work was reported by 13 of the 15 participants. Of the 13 reporting exposure, two reported exposure to crowds of smokers during their workshift and the remaining 11 encountered a mean of 8.8 smokers (SD ± 6.7). The mean reported hours of exposure was 3.4 (SD ± 2.1).

Respirable particle and nicotine concentrations varied widely with the reported number of smokers and hours of exposure. The mean concentrations for RSP and nicotine were 63.9 $\mu g/m^3$ (SD ± 41.5) and 20.4 $\mu g/m^3$ (SD ± 20.6), respectively. Correlations between the atmospheric markers

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TABLE 1—Description of Participants in a Personal Monitoring Study of Exposure to Environmental Tobacco Smoke at Work, New Mexico, 1986–87

Occupation/Workplace	Workshift Duration/ Exposure Duration (hours)	RSP ($\mu g/m^3$)	Nicotine ($\mu g/m^3$)
Males			
Physician/Hospital	8/5	52.3	10.0
Social Worker/Office	8/0	44.0	2.5
Stock Broker/Office	8/2	69.4	7.2
Bus Boy/Restaurant	8/8	145.8	45.0
Maintenance Worker/Retail Store	8/3	85.2	6.9
Barber/Barber Shop	8/0	14.7	4.0
Barber/Barber Shop	8/4	145.8	13.7
Volunteer/Hospital	4/2	80.0	46.0
Females			
Interviewer/Public Transportation	3/2	4.0	0.0
Travel Agent/Office	8/5	85.7	50.0
Travel Agent/Office	6/4	62.1	46.7
Attorney/Office	8/6	63.3	5.9
Volunteer/Hospital	4/3	27.6	6.3
Volunteer/Hospital	4/3	25.2	8.7
Volunteer/Hospital	4/4	53.2	53.2

and the questionnaire measures of exposure to ETS were moderate (Table 2).

As was observed for the atmospheric markers, the post-workshift urinary and salivary cotinine levels varied widely with self-reported exposure. In comparison with pre-workshift levels, post-workshift levels were not consistently increased. The mean pre-workshift urinary and salivary cotinine concentrations were 31.8 ng/mg Cr (SD ± 67.6) and 2.9 ng/ml (SD ± 5.0), respectively. For the post-workshift levels, the corresponding values were 19.7 ng/mg Cr (SD ± 43.2) and 3.5 ng/ml (SD ± 5.9).

Spearman correlation coefficients were calculated to examine the relations among the questionnaire variables, the atmospheric markers, and urinary and salivary cotinine (Table 2). Moderate correlations were obtained for self-reports and cotinine levels, and nicotine levels and cotinine levels. However, RSP levels and cotinine concentrations were not correlated.

TABLE 2—Spearman Correlations between Various Measures of Environmental Tobacco Smoke at Work, New Mexico, 1986–87

Correlated Measures	N	r
RSP ($\mu g/m^3$) with:		
Nicotine	15	0.57*
Total number of smokers	15	0.44
Total hours of exposure	15	0.53*
Postshift urinary cotinine	14	0.05
Postshift salivary cotinine	11	−0.07
Nicotine ($\mu g/m^3$) with:		
Total number of smokers	15	0.62*
Total hours of exposure	15	0.54*
Postshift urinary cotinine	14	0.60*
Postshift salivary cotinine	11	0.46
Postshift urinary cotinine (ng/mg Cr) with:		
Total number of smokers	14	0.39
Total hours of exposure	14	0.57*
Postshift salivary cotinine (ng/ml) with:		
Total number of smokers	11	0.63*
Total hours of exposure	11	0.45

*$p < 0.05$

Discussion

The controversial effects of involuntary smoking in the workplace need further investigation. The conduct of such research would be facilitated by the development of unintrusive and accurate methods of exposure assessment. Alternative approaches include active and passive monitoring, biological markers, and questionnaires. We have shown that personal monitoring for tobacco smoke components can be accomplished in the workplace. However, many employers and employees would not participate in the study because of concern about the wearing of pumps.

Despite the small number of subjects studied in this investigation, objective evidence of exposure to ETS was obtained in various workplaces. The levels of RSP and nicotine were similar to those observed in other investigations.[6,8–10] However, few of these studies included information on the intensity and duration of exposure to ETS.[10]

We observed moderate positive correlations among the questionnaire measures of ETS exposure, the results of personal monitoring for RSP and nicotine, and measurements of urinary cotinine. Each of these types of measures provides a differing index of exposure to ETS.[1] The questionnaire measures that were used assess source strength, but concentrations of ETS are also influenced by room volume and ventilation. Nicotine is a specific marker of exposure to ETS, whereas RSP is nonspecific. Cotinine levels reflect nicotine exposure, but also are determined by timing of specimen collection[10] and uptake and metabolism. Thus, tight concordance among these broad indicators of exposure used in this study would not be anticipated.

Because of the differing characteristics of questionnaires, personal monitoring, and biological markers for assessing ETS exposure, no single method should be considered as optimal for studying the workplace. We recommend that assessment of ETS exposure in indoor environments should utilize multiple approaches to characterize short- and long-term exposures. In population studies, questionnaire measures of exposure offer the simplest approach with personal atmospheric markers and biologic markers providing methods for estimating the potential magnitude of misclassification of self-reported exposure.

ACKNOWLEDGMENTS

The authors thank Dr. Helen Van Vunakis for providing the reagents for the radioimmunoassay and Irene Walkiw for technical assistance in performing the assays.

Supported by a cooperative agreement, EPA CR811650, from the US Environmental Protection Agency. Dr. Coultas is recipient of an Edward Livingston Trudeau Scholar Award from the American Lung Association. Presented in part at Indoor Air Quality '89, sponsored by the American Society of Heating, Refrigerating and Air-Conditioning Engineers and the Society for Occupational and Environmental Health, April 1989.

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Sexual Histories of Heterosexual Couples with One HIV-Infected Partner

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Abstract: Ninety-eight heterosexual couples enrolled in a HIV transmission study, at least one of whom was HIV-infected, were interviewed about sexual behavior. Although males and females were interviewed separately, there was agreement between them on the number of sexual contacts, the practice or anal intercourse, and condom use. These findings of strong reliability are encouraging, but do not necessarily imply that the data are valid. (*Am J Public Health* 1990; 80:990–991.)

Introduction

The best way to prevent the spread of infection from human immunodeficiency virus (HIV) is voluntary behavioral change.[1] Before recommending strategies to promote such changes, one must first establish the kinds of behavior currently practiced. To do so, AIDS (acquired immunodeficiency syndrome) researchers rely almost exclusively on interviewing techniques, but many question the validity and reliability of this methodology.[2] For example, in a study of the reproductive histories of a group of women, Hornsby and Wilcox[3] established that daily logs of sexual behavior were more accurate than comparable data collected through retrospective interviews. Similar results were found by both Udry and Morris[4] and Kunin and Ames,[5] who determined that recent and frequent reporting of sexual behavior produced the most precise results. However, AIDS epidemiologists may not have the opportunity to collect data on a regular basis and are thus forced to rely on retrospective reports of behavior even though the accuracy of these reports (especially for a variety of sexual practices) has not been established. Here I report on the reliability of such data, comparing reports of sexual behavior between men and women in couples of which at least one partner was HIV seropositive.

Methods

Since 1985 we have been conducting a study of the heterosexual transmission of acquired immunodeficiency syndrome (AIDS) in California in which we enroll the opposite sex partners of individuals infected with HIV. Although the study began by enrolling the female partners of HIV-infected men,[6] in 1987 we began to enroll participants as couples. Individuals who test positive for HIV at a variety of sites and who also have heterosexual partners are referred to the study as part of their post-test counseling. Enrollment is voluntary; study protocol is described elsewhere.[6]

Interviewers are female and are matched to couples by ethnicity. They are trained in group and individual sessions that include role playing and interpretation of interview responses. Results were reliable across interviewers. To ascertain number of sexual contacts, the interviewer asks how many times the couple has sexual intercourse in a typical week or month. Deviations from this number throughout the relationship are noted. The total number of contacts is estimated by multiplying the duration of the relationship by the typical reported amount and weighting this number by changes in sexual activity over time. Individuals in the couple are interviewed separately on the same day.

Behaviors considered in this report are: vaginal intercourse, anal intercourse, and condom use. Continuous responses were compared using Pearson's correlation coefficient, and categorical responses were compared using the Kappa coefficient and its corresponding confidence limits as described by Fleiss.[7] HIV infection was ascertained from serological tests using enzyme immunoassays with Western Blot confirmation.

Results

This report includes data from 98 couples, 68 percent of which were monogamous at entry into the study. Most of the men and women reported only one partner in the six months prior to entry into the study. Median number of partners since 1978 (the beginning of the AIDS epidemic) was five for the women and 10 for the men. The overall male-to-female transmission rate from the study which began in 1985 was 24 percent. Seventy-seven of the couples included infected men and their female partners; 12 (16 percent) of these women were infected. Twenty-one of the couples were infected women and their male partners; none of these men were infected. The reported risk group of the infected partner of the 98 couples varied and is described in Table 1. Sixty-three percent of the couples were White, 20 percent Latino, 7 percent Black, 1 percent Asian, and the remainder were couples of mixed ethnicity. Average income for the couples was $20–29,000 per year; average level of education was 13

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